159 Ort Lane
Merlin, OR, US 97532
Phone: +1 541 471 6256
Fax: +1 541 471 6251
www.linxtechnologies.com

HUM-xxx-RC Spread Spectrum Compliance

1. Describe how the EUT meets the definition of a frequency hopping spread spectrum system, found in Section 2.1, based on the technical description.

Note: *From section 2.1 of the FCC Rules: A spread spectrum system in which the carrier is modulated with the coded information in a conventional manner causing a conventional spreading of the RF energy about the frequency carrier. The frequency of the carrier is not fixed but changes at fixed intervals under the direction of a coded sequence. The wide RF bandwidth needed by such a system is not required by spreading of the RF energy about the carrier but rather to accommodate the range of frequencies to which the carrier frequency can hop. The test of a frequency hopping system is that the near term distribution of hops appears random, the long term distribution appears evenly distributed over the hop set, and sequential hops are randomly distributed in both direction and magnitude of change in the hop set.*

The module uses a conventional radio using FSK modulation. The radio is frequency agile and 25 channels have been defined across the 902 – 928MHz band. The channel spacing is 499.878 kHz.

The transmitter hopping pattern is calculated when its transmitter address set. The transmitter sends one control packet on each channel then hops to the next channel in the pattern. Once the transmitter reaches the end of the hopping pattern, it returns to the first channel in the pattern and repeats the cycle. It continues this cycle for as long as the user activates the device, dwelling on each channel for approximately 13.33ms. Once the user deactivates the unit, the transmitter continues transmitting until it reaches the end of the hopping pattern, then turns off.

The receiver cycles through the first four channels in the hopping sequence, approximately one per second, until it receives a valid transmission. Once it receives a valid transmission, it confirms that the transmitter is authorized. If so, the receiver uses the received address of the transmitting unit to determine the rest of the hopping pattern. It then follows the transmitter through the hopping pattern as determined by the elapsed time from the last successfully received packet.

The pseudorandom selection of the channels makes the near term distribution of the hops appear random. The cyclic and sequential use of the channels means that all channels are used the same on average over the long term.

2. Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, in order to demonstrate that the sequence meets the requirement specified in the definition of a frequency hopping spread spectrum system, found in Section 2.1.

The hopping sequence is computed from a fixed primal random permutation of the values 1 to 25 in two sections: channels {2, 16, 20, 22} arranged in slots 1-4 and the remaining channels arranged in slots 5-25. The generated sequence is calculated as four transformations of the primal permutation, using a proprietary hash function of the 32-bit address to select the transformations. The result is that the hopping sequence is computed from the unique address of the transmitter. The primary sequence was generated by an online random permutation generator at www.jerrydallal.com/random/random_permutation.htm. An iteration function uses the hash value and the primary sequence to fill out the hopping pattern.

3. Describe how each individual EUT meets the requirement that each of its hopping channels is used equally on average (e.g., that each new transmission event begins on the next channel in the hopping sequence after the final channel used in the previous transmission event).

Each transmitter has its own fixed hopping sequence containing each channel once. The transmission contains a payload of 8 bytes, resulting in fixed transmission time for a packet. The transmitter sends one packet per channel in the hopping sequence. The number of consecutive packets transmitted depends on the duration of a control line activation, but when external activation stops, the transmitter continues transmitting until a multiple of 25 packets has been transmitted.

4. Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

The IF Bandwidth of the receiver is set to 325 kHz. This captures the carrier and side bands of the FSK modulation with deviation of +- 100 kHz, plus allowance for variation in crystal reference frequency.

5. Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

The transmitter uses a fixed timing of 13.333 ms per channel slot. The receiver waits on one of four fixed beacon channels for an initial packet. Once a packet is received with a valid CRC and format, the receiver checks the address. If the address is in the receiver's address table, the receiver synchronizes to the transmitter by computing the hopping sequence from the address and listening for the next transmitted packet at the proper sequence channel, as determined by the elapsed time from the last successfully received packet.

6. Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

The hopping sequence and system timing were designed specifically for the HumRC module. It is very unlikely that the hopping sequence and timing would be the same as a different FHSS system. Even if so, the receiver will only track transmissions that contain a 32-bit address code within the receiver's valid transmitter table.

+1 541 471 6256
www.linxtechnologies.com